Available online at www.sciencedirect.com
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ELSEVIER
Renewable and Sustainable Energy Reviews 13 (2009) 129–141
RENEWABLE & SUSTAINABLE ENERGY REVIEWS
www.elsevier.com/locate/rser

Assessment of post-Kyoto climate change mitigation regimes impact on sustainable development

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Received 15 June 2007; accepted 20 July 2007

Abstract

This article analyzes post-Kyoto climate change mitigation regimes and their impact on sustainable development. Wide range of post-Kyoto climate change mitigation architectures have different impact on different groups of countries, therefore sustainability assessment is performed for four main group of countries: EU and other Annex-I countries, USA, Advanced Developing Countries and Least Developed Countries. The post-Kyoto climate change mitigation regimes are evaluated based on their economical, environmental, social and political impact for different groups of countries. For the assessment the scoring is applied. The architectures are further ranked according to the best results or highest score obtained during assessment according to all criteria and for all groups of countries.
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Keywords: Post-Kyoto climate change mitigation regimes; Sustainability assessment of policies

Contents

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doi:10.1016/j.rser.2007.07.002

1. Introduction

The increasing concern over climate change drives towards the search of solutions enabling to combat climate change into broader context of sustainable development. The core element of sustainable development is the integration of economic, social and environmental concerns in policy-making. Applying this mode of thinking—seeing climate change through a sustainable development prism—is the only way in tackling the climate change and sharing efforts among countries. The question of biding commitments for GHG emission reductions is a difficult topic complicated by sometimes opposing issues of equity, efficiency, and development. A plethora of post-Kyoto climate change mitigation architectures have been put forward [1].

International and local climate change mitigation policies need to be assessed based on sustainability criteria. Mitigation commitments of countries under an international climate regime could take several forms. Annex-I countries under the Kyoto Protocol have legally binding emission limitation and Non-Annex-I countries have more general commitments but no quantified emission targets. The possible post-Kyoto climate change mitigation architectures can be grouped into eight types of commitments countries could adopt in the future [2]:

1. Binding absolute emission reduction targets.
2. Flexible emission targets (non binding, positively binding, dual targets, price caps, intensity targets).
3. Enhanced coordinated technology RD&D efforts.
4. Coordinated policies and measures (technology standards, taxes, menu of policies and measures).
5. Mandatory financial contributions to funds, technology transfer.
6. Greening of investment flows (e.g. export credit agencies).
7. Sustainable development policies and measures.
8. Enhanced participation in an extended clean development mechanisms.

These types of commitments could be (and are today) applied in parallel, not exclusively. The most prominent type of commitment is the binding absolute emission reduction targets. The target can be reached in a flexible manner across greenhouse gases and sectors as well as across borders through emission trading and/or project based mechanisms (joint implementation and the clean development mechanism). These targets could be applied for Annex-I as well as Non-Annex-I countries in the future. However, several Non-Annex-I countries, as well as the USA, have expressed their concerns about the absolute targets being too rigid and capping economic growth [3].

Three options for selecting countries for groups are defined [4]. For a future system with several stages or with a menu of different types of targets, indicator thresholds for the participation could be set that define when a country has to participate with a particular type of target. Such threshold could be calculated using the following indicators or a combination of them: absolute emissions; emissions per capita; emissions per GDP; GDP per capita; cumulative emissions; contribution to temperature; other measures of development, such as the human development index.

A second option would be that countries themselves decide which group to join. In such a system, incentives have to be provided to motivate countries to move into certain groups, e.g. publicly available and comparable data on the indicators and political pressure.

The third option would be to explicitly link the participation of some developing countries to the success of reductions taken by developed countries.

The aim of the article is to develop and apply the methodological framework for sustainability assessment of various potential post-Kyoto climate change mitigation regimes including agreed form of GHG commitment, legal nature of commitments, accountability, financial and technological commitments, access to flexible mechanisms and other elements of climate change mitigation architecture.

The future international climate regimes will be evaluated based on their impact on sustainable development. The environmental, economic, social and political criteria will be applied to rate and to rank future climate change mitigation architectures. The rating will be based on score system. As the different post-Kyoto climate change mitigation architectures have different impact on different groups of countries, the countries will be grouped into several groups: (EU and other Annex-I countries, USA, Advanced Developing Countries and Least Developed Countries) and post-Kyoto architectures will be evaluated based on scoring according economical, environmental, social and political criteria. The scoring will be applied for each group of countries. The best architectures or having highest positive impact on sustainable development would be ranked according highest scores obtained for all criteria and for all groups of countries.

2. Review of post-Kyoto climate change mitigation approaches

The possibilities for future climate change mitigation commitments vary widely with respect to different kinds of commitments including scope and legal character, use of market-based mechanisms and other important elements of the future climate change mitigation regimes. More than 50 proposals can be find in literature and policy documents [5].

The Kyoto Protocol to United Nation Framework Convention on Climate Change came into force on 16 February 2005. The current world's greatest GHG emission source (USA) and the anticipated larger sources of GHG emission in the future (China and India) are not parties of Kyoto protocol. These omissions and the Kyoto Protocol termination in 2012 have given rise to a large

number of proposed international climate policy architectures.

The climate policy architectures can be grouped in 4 major groups: the frameworks which would achieve the goal to reduce GHG emissions via national emission targets and timetables by which those targets must be attained (targets and time tables); the frameworks which would achieve emission reductions primarily through the adoption by individual nations of agreed-upon policies and measures (i. e., harmonized domestic policies and measures); and frameworks achieving GHG emission reductions primarily through the transfers of technological and other financial resources from industrialized to developing countries (i. e., technological transfers) and frameworks achieving GHG emission reductions by applying sustainable development policies in developing countries and extending CDMs (i.e., sustainable development policies in developing countries). Each climate change mitigation architecture employs one or more international policy mechanisms to achieve goal of reduced GHG emissions, but under most proposals, individual participating countries would have wide latitude in choosing domestic policies to meet their particular national emissions reduction commitment. Therefore the main post-Kyoto architectures can be described in the following way [6]:

- *Targets and timetables*: Specific emissions targets are imposed on each participating country over a certain period. These proposals almost always include flexibility mechanisms, such as emissions trading.
- *Harmonized domestic policies and measures*: The focus is on specific national level policy actions, without defining emissions targets. A coordinated carbon tax collected by each national government would be an example of this.
- *Resource transfer from developed countries to developing*: Mandatory technology and financial flows are mobilized from industrialized to developing countries.
- *Sustainable development policies in developing countries*. Implementation of sustainable development policies in developing countries. The extended clean development mechanisms can be used as a good tool to implement sustainable development policies in developing countries.

The summary of future types of GHG emission commitments is presented in Table 1.

Anticipated post-Kyoto climate policy architectures include wide range of quantified emission commitments. The most prominent type of commitment is the binding absolute emission reduction targets as included in the Kyoto Protocol for Annex-I countries. Such targets provide certainty about future emission levels of the participating countries (assuming targets will be met). The target can be reached in a flexible manner across greenhouse gases and sectors as well as across borders through emission trading and/or project based mechanisms (joint implementation and the clean development mechanism). These targets could be applied for Annex-I as well as Non-Annex I countries. Alternatively, countries could take on flexible emission targets, including the following options [7]:

- Non-binding emission targets, meaning that not reaching them has no consequences. Here emission trading could not be applied.
- "Positively binding" emission targets, meaning that additional emission rights can be sold, if the target is reached, but no additional emission rights have to be bought, if no rights have been sold and the target is still not met.
- "Dual" targets, meaning that two targets are defined, a "selling target", below which emission rights can be sold, and a "buying target", above which emission rights have to be bought.
- "Price cap", meaning that an unlimited number of additional emission rights is provided at a given maximum price.
- Dynamic targets, meaning that targets are expressed as dynamic variables as a function of the GDP ("intensity targets") or variables of physical production (e.g. emissions per tonne of steel produced).

All of these options aim at providing more flexibility to the countries, to avoid extremely high costs of GHG emission reduction. However, providing this flexibility reduces the certainty that a given emission level is really reached.

Another type of climate change mitigation architecture would be to enhance and coordinate technology research, development and deployment efforts. Such activities would influence the development of new technology that will be needed to reduce emissions in the long-term. As another alternative, countries could agree on coordinated policies and measures such as technology standards or taxes on the emission of greenhouse gases. In the negotiations toward

Table 1
Summary of future types of commitments

Quantified emission reduction commitments	1. Binding absolute emission reduction targets 2. Flexible emission targets (non-binding, positively binding, dual targets, price caps, intensity targets)
Action-oriented commitment	3. Enhanced coordinated technology R&D efforts 4. Coordinated policies and measures (technology standards, taxes, menu of policies and measures)
Actions by industrialized countries aimed at avoiding future developing country emissions	5. Mandatory financial contributions to funds, technology transfers 6. Greening of investment flows
Actions taken by developing countries	7. Sustainable development policies and measures 8. Enhanced participation in an extended CDM

Kyoto, harmonized policies and measures were rejected by many countries, because they were seen as prescriptive and leaving less flexibility to the countries compared to emission reduction targets.

Resource transfer from developed to developing countries can also be credible climate change mitigation architecture. One option of this type of architecture would be mandatory contributions to funds and technology transfer. Such funds would finance emissions reduction projects or adaptation activities. A second option for commitments for developed countries that aim at limiting emissions in developing countries would be the ''greening of investment flows''. These are those flows of resources that are currently transferred from developed to developing countries through development banks and export credit agencies.

The last climate change mitigation architecture is based on the commitment of developing countries to adopt sustainable development policies and measures. In this approach, development objectives are formulated first. In a second step, it is considered how climate policies can support these development goals. This approach is very attractive to developing countries as it focuses on their main concern of sustainable development. Another option in this type of architecture for developing countries could be to participate in an enhanced CDM, which would allow sectoral government programmes to be eligible CDM projects.

Very important issue in post-Kyoto climate change mitigation architectures is participation of developing countries. The future climate architectures include five basic degrees of developing country participation [8]:

- *None*: No policy requirements and no emission reductions are imposed on developing countries, although they may receive low-carbon technology or financial aid from industrialized countries. The first commitment period of the Kyoto Protocol is an example.
- *Voluntary*: Developing countries can choose whether to undertake commitments or not, with the expectation that some might do so.
- *Differentiated*: Developing countries have requirements, but they are different from those of industrialized nations over the entire time frame of the proposal.
- *Conditional*: Countries take on graduated requirements as they meet certain conditions, such as a level of per-capita gross domestic product (GDP) or emissions.
- *Full*: The proposal does not have different requirements for countries classified as developing or industrialized.

More detailed overview of the main post-Kyoto climate change mitigation architectures widely discussed in scientific literature and based on targets and timetables (Continuing Kyoto, multi-stage approach, contraction and convergence, Triptych, multi-sector convergence, Brazilian proposal, commitment to human development with low emissions) is provided below.

The ''continuing Kyoto'' approach is widely discussed in scientific literature. The Kyoto Protocol provides a very flexible structure, which could incorporate many of the approaches described above. For example, the converging per capita emissions or intensity targets could be included in a second commitment period of the Kyoto Protocol. Essentially, most other approaches could be called ''continuing Kyoto''. When referring to ''continuing Kyoto'' or ''increasing participation'', often the key features of the Kyoto Protocol are meant, which include [9]:

- Maintaining two groups of countries, Annex-I and Non-Annex-I, assuming that gradually countries move into Annex-I.
- Binding absolute emissions reduction targets for Annex I countries for a basket of greenhouse gases.
- Flexibility through Kyoto mechanisms, such as emissions trading (ET), joint implementation (JI) and the clean development mechanism (CDM).

Some also refer to a ''Kyoto plus'' approach, where the main features are kept and only minor additional changes are made. Intensity targets instead of absolute targets or other minor adjustments such as ''price caps'' or only ''positively binding targets'' can be introduced as an interim measure for some or all developing countries.

The ''multi-stage approach'' assumes that countries gradually move through several stages in between Annex I and Non-Annex I countries with respect to increasing stringency, as opposed to the current system of two stages (Annex-I and Non-Annex I) [10]. This approach would reflect that countries today have different levels of economic development and therefore have different obligations under a future climate treaty. This approach was developed by German company ECOFYS [11] and in literature is called Germany multi-stage approach. The starting point for grouping countries is to assess their characteristics and to define, to what stage they best correspond. Usually a country ''graduates'' into the next stage, when it exceeds a certain threshold expressed in, e.g. emissions per capita or GDP per capita. Such multi-stage approaches are developed by a number of organizations. One option would be to define four such stages e.g.:

1. No commitments stage, where countries have no binding emission obligations (as the current Non-Annex I);
2. Decarbonisation stage, where countries will have GHG intensity targets expressed as emissions per GDP;
3. Stabilization stage, where countries stabilize their absolute emissions;
4. Reduction stage, where countries need to reduce their absolute emissions.

The critical issue about this approach is to ensure that a sufficient number of countries move to higher stages. Regular review of each country's situation and assessment

whether it graduates into the next stage would be necessary.

"Contraction and convergence" approach is also based on targets and timetables [12,13]. This approach was developed by Global Commons Institute (GCI). With the "contraction and convergence" approach, all countries would agree on a global target of, e.g. 450 ppmv stable concentration of carbon dioxide in the atmosphere. They would also agree on a path of yearly global emissions that lead to that concentration level (contraction). In a second step, the global emission limit for each year would be shared among all countries, including developing countries, so that per-capita emissions converge by a specific date, e.g. 2050 (convergence). The defined targets for each country can be reviewed and revised when new scientific findings require it. This approach allows for full emissions trading. As all countries participate, those countries with less allowances than needed (e.g. industrialized countries) can buy allowances from other countries that receive excess allowances (e.g. least developed countries). If stringent stabilization levels such as 450 ppmv CO_2 are to be reached, convergence to a per capita emission level below current Non-Annex I average is needed. Consequently, benefits from transfer of resources will be limited to the least-developed countries and to the first decades of operation of the system. This approach has very simple rules. Two major issues need to be negotiated and agreed upon: the target atmospheric concentration of CO_2 and the date, at which the entitlements would converge at equal per capita allocations.

Very popular and widely discussed approach based on targets and timetables is "multi-sector convergence" approach [14]. The "multi-sector convergence" approach applies the principle of converging per-capita emissions to emissions of individual sectors and not on the national level (as the contraction and convergence approach). High-emission countries have sectoral level convergence in allocations and developing country participation conditional on becoming high-emission country. The convergence level for each sector and the date when convergence should be achieved are defined beforehand based on technical potential. They are also open to political negotiations. This approach can, in principle, be applied on a global scale. It can include all greenhouse emission gases currently covered under the Kyoto Protocol. The multi-sector convergence approach takes into consideration the different emission structures of the countries. It can take into account that emissions from some sectors, e.g. transport, are difficult to reduce (resulting in a high sector per-capita convergence level), while emissions in other sectors, e.g. from landfills, are relatively easy to reduce (resulting in low sector per-capita convergence levels).

Quite complicated proposal for future GHG mitigation commitments based on targets and timetables was developed by Brazilian government and is called Brazilian proposal [15]. This approach provides the method to share emission reductions amongst countries. It was proposed to attribute responsibilities to countries according to the impact of their historical emissions on the surface temperature change and to share emission reduction efforts proportional to their historical contribution. The approach requires a complex analysis to identify historic emissions and attribute country's contributions to temperature change, which is subject to further research. In general, countries with a longer process of industrialization and thus a longer record of greenhouse gas emissions will have a greater share of responsibility for emission reductions than countries where industrialization started later.

The Triptych approach developed by University of Utrecht and is based on a method to share emission allowances among a group of countries, based on sectoral considerations [16]. The approach can theoretically be applied to any group of countries. The Triptych approach originally distinguished three broad emission sectors: the power sector, the sector of energy-intensive industries and the "domestic" sectors (e.g. residential and transport emissions). The selection of these sectors was based on a number of differences in national circumstances raised in the negotiations that are relevant to emissions and emission reduction potentials: differences in standard of living, in fuel mix for the generation of electricity, in economic structure and the competitiveness of internationally oriented industries. The approach was later extended to include deforestation and emissions of methane and nitrous oxide. The emissions of the sectors are treated differently: For electricity production and industrial production, a growth in the physical production is assumed together with an improvement in production efficiency. This takes into account the need for economic development. For the "domestic" sectors, convergence of per-capita emissions is assumed. This takes into account the converging living standard of the countries. The allowances of the sectors are added up to a fixed national allowance for each country. Only one national target per country is proposed, no sectoral targets, to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

The "Commitment to human development with low emissions" approach draws a line between basic and luxury goods of human beings and associated emissions [17]. Having a decent living standard and meeting human being basic needs would not result in taking on commitments to reduce greenhouse gases. The problem with anthropogenic greenhouse gas emissions lies within the consumption of luxury goods that go beyond the basic needs and thus generate GHG emissions that are not necessary. Unresolved in this approach is the line between basic and luxury consumption and thus basic and luxury GHG emissions. In addition, those products and services need to be identified, that would be acceptable under a decent living standard and which would not.

The sustainability assessment of these seven most probable post-Kyoto climate change mitigation architectures will be performed further. However, the criteria for

assessment of post-Kyoto climate change mitigation architectures needs to be discussed first of all. The following chapter provides the methodological framework for assessment of policy impact on sustainable development and discusses criteria necessary for such type of assessment.

3. Assessment of policy impact on sustainable development

3.1. World Energy Council approach for sustainability assessment of climate policies

Considering the likely impacts of their energy policy measures, governments should give more attention to monitoring their effects in practice. There is evidence that many measures are not in practice meeting the objectives they are aimed at, like lowering emissions. Very few policy measures have been assessed in a holistic way against all three energy sustainability dimensions identified by World Energy Council [18]. In 2000, the World Energy Council published a statement ''Energy for Tomorrow's World—Acting Now'' which looked at the challenges the world faced in meeting its energy needs in the 21st Century. The following description of the three WEC energy goals is extracted from that document.

WEC considers economic growth together with national and international institutional reforms essential to energy accessibility for everyone, including the poorest two billion people in the world. When only some individuals or regions of the world benefit from energy development and others are left behind, the ensuing political and social instability can pose a significant threat to world peace and, in turn, to energy availability through supply disruptions. In addition to the impact of accessibility on energy availability, it is also linked closely to energy acceptability. Investment partnerships to achieve energy accessibility and availability could also address social and environmental issues.

Accessibility is the provision of reliable and affordable modern energy services for which a payment is made. It depends on policies specifically targeted to meeting the needs of the poor, in the context of increasing reliance on market signals. The best way to ensure that a growing number of people will be able to afford commercial energy in line with their needs is to accelerate economic growth and pursue more equitable income distribution. This requires increasing reliance on the market, while addressing cases of market ''failure'' with special policies. An energy tariff reflecting all costs, including external costs such as emissions or waste management, is necessary to secure adequate investment and encourage energy efficiency and environmentally preferred technologies, but such a tariff would be unaffordable for many people. At the same time, a tariff subsidized down to a socially affordable price would not attract sufficient investment, consequently in the long-run working against the interests of those who are in need of commercial energy infrastructure. There may be a need, in some cases, to subsidize energy technology and delivery for a period of time without creating price distortions or at least by keeping them to a minimum. Variable, maintenance and extension costs need to be reflected in the price paid for energy, but sunk costs might be handled differently in some circumstances.

Availability covers both quality and reliability of delivered energy. The continuity of energy supply, particularly electricity, is essential in the 21st Century. While short-term interruptible supply may be feasible in certain circumstances as long as the conditions are known and understood by customers, unexpected power-cuts bear a high cost for society that cannot be ignored. The world's growing reliance on information technologies makes reliability even more critical. Energy availability requires a diversified energy portfolio consistent with particular national circumstances together with the means to harness potential new energy sources. Most WEC Member Committees agree that all energy resources will be needed over the next 50 years and there is no case for the arbitrary exclusion of any source of energy.

Acceptability addresses environmental goals and public attitudes. Local pollution is a cause of harm to billions of people, especially in developing countries. Global climate change has become an important concern. Mindful of these two facts, developing countries are concerned about both the potential impact of climate-change-related response measures on their economies, and the rising levels of consumer-based household emissions, which create local (urban) and regional pollution (e.g. such as acid rain's impact on crops and forests). The energy sector is one area in which new and readily available technologies have already reduced emissions and hold out prospects for future improvement. Of course, environmentally friendly technologies have to be developed, diffused, maintained and expanded in all parts of the world. Hence, there is a need to foster adequate local capacity to ensure that the technologies can be used and maintained by local people. Energy resources must be produced and used in a manner that protects and preserves the local and global environment now and in the future.

The main climate change mitigation policies including local and international consist of energy and carbon taxes, removal of subsidies on fossil fuels, emission trading schemes, subsidies to low carbon energy options including renewable energy sources and energy efficiency measures, regulations and standards, voluntary agreements and information and awareness. Based on results of WEC ''Energy and Climate Change Study'' the evaluation of climate change mitigation measures implemented Baltic States according to 3 dimensions of sustainable energy development (acceptability, availability and accessibility) will be performed. The evaluation is carried out on scoring for each criteria of each policy measure on a scale of 1 to 5, with 1 representing the lowest assessment and 5 the highest:

5—The impact of climate change mitigation instrument on acceptability, availability and accessibility is very positive.

4—The impact of climate change mitigation instrument on acceptability, availability and accessibility is good.
3—The impact of climate change mitigation instrument on acceptability, availability and accessibility is poor.
2—The impact of climate change mitigation instrument on acceptability, availability and accessibility is week.
1—The impact of climate change mitigation instrument on acceptability, availability and accessibility is negative.

3.2. Sustainability assessment of climate change mitigation policies in Baltic States

The Baltic States have very similar GHG mitigation policies in measures in place driven by EU accession. Baltic States have implemented measures to promote the use of renewable energy sources or having impact on the utilization of renewable energy sources: pollution taxes, fuel taxes, VAT and excise tax allowances for biomass and biofuel, feed-in prices for electricity produced from renewable energy sources. GHG emission trading schemes has been implemented in Baltic States since January 2005. Estonia distinguishes from the Baltic States with a voluntary green certificate trading system; CO_2 tax is implemented in Estonia and Latvia [19]. The assessment of climate change mitigation measures implemented in Baltic States with respect to the 3 A's of WEC results is presented in Table 2.

All climate change mitigation measures implemented in Baltic States except energy tax can be scored relatively highly against the criterion of environmental acceptability except energy taxes because energy taxation falls mostly on motor fuels, although the main source of GHG emissions is not the use of motor fuel. The impact of CO_2 tax on availability is scored by 4 because it has some negative impact on security of energy supply because of increasing price of energy and discouraging investments in energy sector. The same is applicable to energy tax. Feed-in prices for RES also have impact on energy price increase in the system and because of penetration of RES in electricity market has negative impact on stability of electricity supply system in the country [20]. Green certificates are scored higher because the system has lower negative impact on energy price increase comparing with feed-in tariffs though the problem of RES penetration in electricity system is similar. GHG emission trading has the same general problems as CO_2 taxes in relation to availability with additional difficulty of uncertainty of GHG emission trading schemes impact on energy prices, etc. Financial measures have high score because they enable energy suppliers to get additional subsidies for European Union to use them as investments for RES development and energy efficiency measures without increasing energy price to consumers and therefore the impact on energy supply availability is positive [21].

The impact of CO_2 tax on accessibility is quite negative as they have tendency to impose higher burdens on the poor than on the rich when price of energy is going up. The same is applicable to energy tax as the poorest are more vulnerable to energy price increase because of high energy taxes. GHG emission trading, green tradable certificates are scored on higher score because emission trading (including all international Kyoto mechanisms) and tradable green certificates are more flexible tools comparing with CO_2 taxes or feed-in prices and have lower impact on energy price increase and the most important that these schemes could make a strong contribution to accessibility worldwide as could lead to money transfers to developing countries from developed countries [22]. Financial measures for EU Structural Funds are scored relatively highly against accessibility criteria as they do not have negative impact on energy price increase, just provide capital investments for RES and energy efficiency measures development, and also have positive impact on regional development and increase of income and employment of inhabitants in rural areas [23].

Assessment of climate change mitigation instruments implemented in Baltic States with respect to the 3 A's of WEC results in the following ranking:

1. Financial measures from structural funds;
2. Green tradable certificates;
3. GHG emission trading;
4. Feed-in tariffs for CHP;
5. Feed-in tariffs for RES and CO_2 tax;
6. Energy tax.

Table 2
Assessment of GHG mitigation measures in Lithuania with respect of 3 A's

Policy measure	Acceptability	Availability	Accessibility	Total ranking
CO_2 tax	4	3	1	8
GHG emission trading	4	3	3	10
Energy (excise) tax	4	2	1	7
Feed-in tariffs for RES	4	2	2	8
Feed-in tariffs for CHP	4	3	2	9
Green certificates	4	4	3	11
Financial measures from structural funds	4	4	4	12

4. The main criteria for selecting the future international climate change mitigation regimes

4.1. Analysis of sustainability criteria from different countries perspectives

There are different expectations of countries or country groups towards a future international climate regime. First a detailed list of criteria was developed against which various approaches can be checked [7,8]. The main criteria of sustainable energy development are: acceptability or environmental criteria, availability or economic criteria, accessibility or social (political from international perspective) criteria. Starting from the identified criteria, selected country perspectives (EU and Annex-I countries, USA, Advanced Developing Countries and Least Developed Countries) were then summarized (Table 3) and possible areas of conflict between different groups of countries were identified [7] based on score rating on a scale of 1 to 5 with the following representation of scores:

5—"Fulfillment of the criterion is very important for the player".
4—"Fulfillment of the criterion is quite important for the player".
3—"Fulfillment of the criterion important for the player".
2—"Player is indifferent towards this criterion".
1—"Fulfillment of the criterion is not desired by the player".

As one can see from Table 3 general points of agreement can be observed. Several criteria seem to be important for all major players considered here. Such criteria should be fulfilled by any future regime; they are uncontroversial. The uncontroversial environmental criteria include the comprehensiveness of the systems, and the less important avoiding leakage effects and unintentional "hot air". Many countries would also subscribe to most of the economic criteria such as minimizing negative economic effects, generating positive economic side effects, stimulating technological change and providing incentives for technology spillover, accounting for structural differences of countries and certainty about costs. The equity principles "capability" and "comparable efforts" are also generally accepted. As long as these criteria are formulated in such general way, they are generally acceptable. But it depends on the details of the future regime, whether countries will view these criteria as fulfilled or not.

4.2. Potential conflicts between countries

Potential conflicts lie in other criteria. Countries or country groups have different potential expectations of a future commitments regime and for some criteria views strongly oppose. From the assessment presented, the four major conflicts that need to be addressed with care in future climate negotiations. They are: economic efficiency versus environmental effectiveness, involvement of developing countries, mitigation versus adaptation and extension of Kyoto or development of new Protocol.

Table 3
Assessment of countries' perceived emphasis on 3 A's criteria for future climate regimes

Category of criteria sub-criteria	EU27 Annex I	USA	Advanced developing countries (ADCs)	Least developed countries (LDCs)
Environmental criteria (acceptability)				
Putting emphasis on environmental effectiveness	5	1	2	3
Participation of industrialized countries	4	2	5	5
Encouraging early action	3	4	2	2
Involvement of developing countries	4	5	1	1
Avoiding leakage effects	4	3	–	–
Avoiding unintentional "hot air"	2	2	2	2
Integrating adaptation and sustainable development	2	2	5	5
Economic criteria (availability)				
Minimizing negative economic effects	4	5	5	5
Promoting growth of developing countries	4	2	5	5
Stimulating technological change and providing incentives for technology spill-over	4	5	4	4
Accounting for structural differences between countries	5	5	5	5
Certainty about costs	4	5	4	2
Social or political criteria (accessibility)				
Meeting own equity principle "Needs"	4	5	5	5
Meeting equity principle "Capability"	4	2	5	5
Meeting equity principle "Responsibility"	5	2	5	5
Meeting equity principle "Equal rights"	2	1	3	4
Meeting equity principle "Comparable efforts"	5	2	4	4

The most prominent conflict lies within the fundamental approach to the problem of climate change: Some players, most prominently the USA, approach it as an economic problem. To keep the costs for reducing GHG emissions at a minimum bearable level has highest priority. Emphasis is given to short-term economic considerations rather than to long-term environmental objectives. Hence, emission reductions are not treated with urgency; one is preparing to act later through, e.g. technology development. Some other players, in particular the EU and LDCs, put instead high priority to the environmental aspect of the problem and stress the urgency to act. For these groups of countries, keeping global emissions low has the highest priority. Those countries would prefer to work towards defining a joint long-term goal. This fundamental conflict is between the USA and advanced developing countries on the one side and the EU and least developed countries on the other side.

The UNFCCC states that Parties should protect the climate system "in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof." With the Kyoto Protocol, such a first step for Annex-I countries was negotiated. Since the Kyoto Protocol still has not entered into force, two fundamentally different positions still exist: On the one hand, the group of developing countries is of the view that industrialized countries have not yet "taken the lead" and should commit to further reductions due to the fact that they started emitting greenhouse gases many decades ago and therefore carry most historic responsibility. Developing countries will only commit to act, once proven progress has been made by Annex-I countries to reduce emissions. On this conflicting issue, which is essentially between the USA (and to a lesser extent the EU) and advanced developing countries, a compromise has to be found [10].

Another conflict area is the relation between mitigation and adaptation. Some countries are more vulnerable than others to climate change, e.g. countries with low-lying coastal areas. In most cases, these countries do not have the financial resources to cope with the effects of climate change themselves such as sea level rise, accelerated soil erosion and increased risks of storm flooding. They therefore need considerable financial assistance today or in the very near future. These most vulnerable and affected countries therefore call for early and effective adaptation measures as part of their sustainable development and argue that a future climate change regime should support their sustainable development in general. For another group of countries, mitigation, the reduction of greenhouse gas emissions, is of priority rather than adaptation. They argue that mitigation measures are the best means to adapt to climate change, thus a future regime should focus on further reducing emissions. Those countries are not completely against adaptation measures but the immediate need for adaptation with its immediate effects needs to be balanced with mitigation efforts, which show an effect only with some time delay. Attention on adaptation should not distract from the need to reduce emissions. This fundamental conflict is between the USA and the EU on the one side and the developing countries on the other [7].

Some countries, lead by the EU, clearly stated that a second commitment period of the Kyoto Protocol is the only way forward in international climate policy. Building upon the existing elements and the institutional structure would avoid time-consuming and costly future negotiations on a completely new institutional setup. One should make use of as many elements (technical and institutional structures) of the Kyoto Protocol as possible when strengthening the overall mitigation efforts. Some other countries, led by the USA, have taken a very different position, arguing that the Kyoto Protocol includes too many flaws and does not provide a good basis for a continued discussion on future actions to mitigate climate change. Abandoning the Kyoto Protocol, setting up some other mechanism is therefore favoured by those countries. Strong, almost emotional sentiments are brought forward in favour or against the Kyoto Protocol. Yet it is unclear, exactly which elements are to be rejected and which could possibly be kept. The main conflict is between USA and EU. As these conflicts exist between group of countries seeking to evaluate post-Kyoto climate change mitigation architectures, the aforementioned criteria will be applied to different architectures and rating according to 3 A's will be provided for groups of countries following the same methodology described above following approach developed by WEC on evaluation of local climate change mitigation policies [18].

5. Assessment of post-Kyoto climate change mitigation regimes based on sustainability criteria

The main approaches of post-Kyoto commitment schemes widely discussed in scientific literature and political documents are based on targets and timetables except the commitment of human development with low emissions. The following schemes will be further evaluated based on sustainability criteria described above:

- Continuing Kyoto by accepting biding absolute emission reduction targets.
- Multi-stage approach assuming that countries gradually move through several stages in between Annex-I and non-Annex I countries with respect to increasing stringency.
- Contraction and convergence approach means that all countries would agree on a global target of stable concentrations of CO_2 in the atmosphere and they would also agree on a path of yearly global emissions that lead to that concentration level and the global emission limit will be shared among all countries so that per capita emissions converge by a specific date.

- Multi-sector convergence approach applies the principle of converging per capita emissions to emissions of individual sectors and not on the national level.
- Brazilian proposal is based on the method to share emission reductions amongst countries according to the impact of their historical emissions on the surface temperature change and to share responsibilities proportionally to their historical contributions.
- Triptych approach is a method to share emission allowances among group of countries based on sectoral considerations including the power sector, energy-intensive industries and the domestic sectors.
- Commitment to human development with low emissions approach draws a line between basic and luxury goods of human beings basic needs and associated emissions.

Further the evaluation of post-Kyoto climate change mitigation regimes will be evaluated according to 3 A's (acceptability, availability and accessibility) for 3 groups of countries (EU27 and Annex-I countries, USA, Advanced Developing Countries and Least Developed Countries). The main sub-criteria for environmental, economic and social criteria are provided in Table 3. The evaluation is carried out on scoring for each criteria of each policy measure on a scale of 1 to 5, with 1 representing the lowest assessment and 5 the highest score:

5—The impact of climate change mitigation instrument on acceptability, availability and accessibility is very positive for group of countries.
4—The impact of climate change mitigation instrument on acceptability, availability and accessibility is good for group of countries.
3—The impact of climate change mitigation instrument on acceptability, availability and accessibility is poor for group of countries.
2—The impact of climate change mitigation instrument on acceptability, availability and accessibility is week for group of countries.
1—The impact of climate change mitigation instrument on acceptability, availability and accessibility is negative for group of countries.

The evaluation has been made based on the position of group of countries and possible conflicts described in previous chapter. The results of scoring for group of countries are provided in Table 4.

The ''continuing Kyoto'' is the approach widely accepted by EU 27, Annex-I countries and some other developed and least developed countries. Some other countries mainly led by USA are arguing that Kyoto Protocol includes too many flaws and does not provide good basis for negotiation. USA is treating Kyoto Protocol and continuing Kyoto negatively because of negative impact on economic development, energy affordability and accessibility because of energy price increase in case of Kyoto Protocol restrictions implemented in USA economy. Also official opinion in USA is negative regarding environmental acceptability of Kyoto protocol process therefore the scoring provided in Table 4 indicates very low rating according all A's for USA. Completely different situation is obtained for scoring this architecture for EU 27 and other Annex-I countries according sustainable energy development criteria. The EU 27 clearly stated that a second commitment period of the Kyoto Protocol is the best way forward in international climate policy from environmental, economic and social–political point of view. For the Least Developed Countries the score is quite high as continuing Kyoto approach involve non-binding, no-lose or conditional targets in extended Kyoto protocol climate architecture. The situation with Advanced Developing Countries is different as for these countries the requirement to take commitments for GHG emission reduction is foreseen in post-Kyoto approach therefore the impact of this climate change mitigation regime will have negative impact of economic growth of these countries as well as on energy price increase and would cause problems of energy accessibility and affordability. The total score of the scheme for all groups of countries according to all criteria is 38.

Multi stage approach is scored badly for USA and Advanced Developing Countries but for different reasons. For USA the multi-stage approach is evaluated poorly because the GHG emission per capita or GDP per capita are the main characteristics to group countries and impose the commitments of different stringency. According to this approach USA commitments should be the most stringent one. For ADC the economic growth would put them from non-Annex I to Annex-I and the GHG emission commitments would be imposed on these countries consequently having negative impact on economic growth and increase in energy price; therefore according to availability and accessibility criteria this scheme is scored badly for this group of countries. For LDCs the multi-stage approach has received quite high scores, as they will not be forced to take commitments for GHG emission reductions because of their low GDP or GHG emissions per-capita. For EU 27 and other Annex-I countries this approach is scored similarly to LDCs but of course because of different reasons. The EU 27 and other Annex-I countries are not sure that this approach is able to ensure that sufficient number of countries move to new, higher stages and additional costs would be needed to maintain this scheme because of monitoring and assessment of countries required to transfer them to new higher stages. The total score of the scheme for all groups of countries according to all criteria is 24.

Contraction and convergence approach based on an equal per-capita allocation in schemes based on entitlements does not favour industrialized countries. This scheme, for example, would call for the USA to reduce its present emissions by over 90% [24]. In this respect, USA fares worse than other industrialized countries, which currently have lower per capita emissions. Therefore this

Table 4
Assessment of countries' perceived emphasis on criteria for future climate regimes

Category of criteria	EU27, Annex I	USA	Advanced developing countries (ADCs)	Least developed countries (LDCs)
Continuing Kyoto or introducing binding absolute emission reduction targets				
Acceptability	5	1	3	5
Availability	5	1	2	4
Accessibility	5	1	2	4
Total score: 38	15	3	7	13
Multi-stage approach				
Acceptability	3	1	1	3
Availability	3	1	1	3
Accessibility	3	1	1	3
Total score: 24	9	3	3	9
Contraction and convergence				
Acceptability	2	1	1	2
Availability	2	1	1	2
Accessibility	2	1	1	1
Total score: 17	6	3	3	5
Brazilian proposal				
Acceptability	1	2	5	4
Availability	1	2	5	4
Accessibility	1	2	5	4
Total score: 36	3	6	15	12
Triptych approach				
Acceptability	3	1	2	3
Availability	3	1	2	3
Accessibility	3	1	2	2
Total score: 26	9	3	6	8
Multi-sector convergence				
Acceptability	3	1	2	3
Availability	3	1	2	3
Accessibility	3	1	2	2
Total score: 26	9	3	6	8
Commitment to human development with low emissions				
Acceptability	2	1	3	5
Availability	2	1	3	5
Accessibility	2	1	4	5
Total score: 34	6	3	10	15

scheme scores badly for USA according to all criteria. According to contraction and convergence approach some advanced developing countries (Thailand, Venezuela, China, etc.) with their relatively high per-capita emissions are required to start reducing their emission intensities immediately. A western type of industrialization based on heavy industry fossil fuel use and rapidly increasing motorized private transport is not compatible with contraction and convergence approach, therefore for ADC this scheme scores poorly. For LDCs as this model does not support a development path for developing countries similar to that taken by many industrialized countries it does not fulfill the social and political criteria especially equity one. For EU 27 and other Annex-I this approach would require EU member states to follow their current downward trend which can be achieved by continued structural change in the production system. Economic growth has to continue its shift towards lighter sectors of economy such as services and information and communication technologies, however, more strict and expensive measures for energy saving needs to be introduced having impact on economic growth and competitiveness of EU economy. The total score of the scheme for all groups of countries according to all criteria is 17.

According to the Brazilian proposal, countries with longer process of industrialization and longer record of industrialization will have a greater share of responsibility for emission reductions than countries where industrialization started later. This approach receives the highest score for ADCs group and LDCs as they started industrialization recently. The lowest score is for EU 27 and Annex-I countries in Europe as the industrialization was first started in Europe. The total score of the scheme is quite high as 36

because of high scores obtained by ADCs and LDCs countries.

The Triptych approach is the most sophisticated approach to share emission allowances between countries based on sectoral considerations. An earlier version of Triptych approach has been implemented in EU successfully when sharing the Kyoto targets and can be successfully applied globally. Due to sectoral detail it accommodates many national circumstances and concerns of many countries. Countries that rely on coal (like China or India) may further use coal but have to increase their efficiency. Countries that rely on the export of energy intensive goods may continue to produce those but have to improve their efficiency. The general standard of living and individual consumption would converge. The Triptych parameters have to be set in a relatively stringent way to leave room for production growth. Applying this approach leads to substantial reduction requirements for industrialized countries, in particular, those countries with carbon intensive industries including USA and new EU member states. Therefore the scheme is scored at low score for USA and LDCs. For EU this approach though previously successfully applied within EU is not very welcomed because of complexity and high implementation costs including data collection, analysis, evaluation, verification and monitoring; therefore the rating is lower than continuing Kyoto approach. For LDCs the Triptych approach allows for incorporating economic growth and improving efficiency and allows substantial emission increase for LDCs, however, mostly below their reference scenario. The total score of the scheme for all groups of countries according to all criteria is 26.

Multi-sector convergence approach takes into account different emission structures of the countries and is quite similar to Triptych approach which is more sophisticated. This approach is favorable to LDCs and least favorable for USA. The total score of the scheme for all groups of countries according to all criteria is the same as for Triptych approach, that is, 26.

Commitment to human development with low emissions approach implies the requirement to reduce consumption of luxury goods that go beyond the basic needs. This approach is scored especially badly for USA and very well for LDCs. For ADCs this approach is also scored well as these countries do not need to take strict GHG emission obligation now. For EU 27 and other Annex-I countries this scheme does not seem very attractive because of problems related with requirements to draw the line between basic and luxury consumption and to collect no transparent data and to identify those products and services that would be acceptable under a decent living standards, etc. The total score of the scheme for all groups of countries according all criteria is quite high as 34; however, the implementation of this scheme seems not realistic because of technical issues.

As one can see from data presented in Table 4 continuing Kyoto or introduction of legally binding targets for Annex-I countries and non-binding targets for Annex-I countries is the best option for all group of countries according to three dimensions of sustainable energy development (acceptability, availability and accessibility) as the total score is 38. The lowest score received contraction and convergence approach. The results of evaluation for multi-stage, Triptych and multi-sector schemes are similar. The high scoring of commitment to human development with low emissions approach received a high score as 34 because of very high scoring for LDCs and ADCs.

6. Conclusion

1. The core tenet of sustainable energy development is the integration of economic, social and environmental concerns in energy policy making. Applying this mode of thinking—seeing climate change through a sustainable energy development lens—could help in tackling the climate change mitigation in harmonized way with other policies targeting sustainable energy development targets, achieve synergies in these policies and ensure that proposed climate change mitigation regimes would have positive impact on sustainable energy development.
2. The policy makers need to select the best climate change mitigation tool based on several criteria of sustainable energy development encompassing economic, social and environmental one. When policy-makers are asked to choose the instruments for climate change mitigation they have to find a solution that gives the best outcome in terms of sustainability. Multiple criteria decision analysis allow to select the best policy tool and ensure the synergy in policies aiming climate change mitigation and sustainable development and to develop the harmonized policies framework.
3. At present most assessments of climate change measures are partial and incomplete. A more holistic assessment—against economic, social and environmental dimensions of sustainable development called 3 A's (acceptability, availability and accessibility) developed by WEC—would not only ensure that the measures were likely to be more effective in a wider sense in promoting sustainable development, but would also help make them more viable in a narrower sense—that is, more acceptable to those affected and therefore easier to introduce and get supported—and thus more likely to achieve their goals.
4. The analysis of possible post-Kyoto climate change mitigation architectures was performed based on 3 criteria of sustainable energy development. Several criteria are perceived important by all major countries or country groups. These uncontroversial criteria should always be satisfied when designing a future international climate regime and there include economic, environmental, social and environmental criteria.
5. Based on our analysis of international post-Kyoto climate change mitigation regimes according to 3 A's the most suitable future regime would be flexible

emission reduction targets via continuing Kyoto approach. This approach provides the highest advantages relative to the critical criteria of sustainable energy development: acceptability, accessibility and availability for all groups of countries. The lowest score have been received by contraction and convergence approach. The results of evaluation for multi-stage, Triptych and multi-sector schemes were very close and scoring provided is lower. The high scoring of commitment to human development with low emissions approach received a high score of 34 because of very high scoring for LDCs and ADCs.

Acknowledgment

The work was carried out within the frame of International Atomic Energy Agency coordinated research project on ‘‘GHG mitigation strategies and energy options’’.

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